

In § 5 is studied the case of induced currents. Since any disturbance in the field (however arbitrary) can be expressed, as regards the time, by a series of simple harmonic terms, it is sufficient to consider the case when the variations in the inducing system follow the simple harmonic law. This case has, moreover, acquired a special interest since the invention of the telephone. The two extreme cases, where the period of the variation in the field is very large or very small in comparison with the time of decay of free currents in the sphere, are discussed in some detail.

In § 6 the case of a thin spherical *shell* is briefly examined.

I next proceed to investigate what modifications must be introduced into the methods and the results of the preceding sections when the substance of the sphere is susceptible of magnetisation. This occupies §§ 7, 8, 9, 10.

In the remaining sections of the paper I investigate the solution of our fundamental equations, taking account of the finite value of v . The corrections to our former results are of most interest in the solutions of the second type. Although the preceding theory, based on the assumption $v=\infty$, is sufficient for all purposes of comparison with experiment, there are certain processes of (at all events) theoretical interest of which it fails altogether to give an account, viz., all those cases in which any change in the superficial electrification of the sphere takes place. For the expression of these the solutions of the second type are appropriate. There is no difficulty in working out the requisite formulæ, but in the application to the case of *free* motion a difficulty of interpretation arises, which is noticed in the proper place.

III. "Observations on the Colouring-matters of the so-called Bile of Invertebrates, on those of the Bile of Vertebrates, and on some unusual Urine Pigments, &c." By CHARLES A. MACMUNN, B.A., M.D. Communicated by Dr. M. FOSTER, Sec. R.S. Received March 8, 1883.

(Abstract.)

In this paper the result of a systematic examination of the bile and various extracts of the livers of Mollusca and Arthropoda, and of the pyloric or radial cæca and other appendages of the digestive system of Echinodermata is described. The universal distribution of one colouring-matter, which by appropriate experiments is shown to be a chlorophyll pigment, is proved. It occurs in the above organs and can be detected in the bile of specimens of *Helix* after a six months' fast;

for this colouring-matter, since it is found in the appendages of the enteron, the name enterochlorophyll is proposed. The slight differences observable in different cases are shown to be due to the probable greater or less amount of the usual chlorophyll constituents,—blue chlorophyll, yellow chlorophyll, and chlorofucine,—and the presence of xanthophyll, lutein or tetronerythrin. Enterochlorophyll is shown to be much more abundant in the livers of Mollusca and in Echinodermata than in Crustacea, as the livers of the last generally contain more lutein, or sometimes tetronerythrin.

The presence of reduced hæmatin is also demonstrated in the bile of the crayfish and in several pulmonate Mollusca, and its respiratory and other uses discussed.

The conclusions which these observations and others led to are summed up as follows:—

(1.) The existence of enterochlorophyll in the so-called liver, or other appendages of the enteron in Invertebrates is definitely established.

(2.) This pigment occurs in greatest abundance in Mollusca, it occurs less frequently in Arthropoda, and its presence in Vermes is not proved.

(3.) The pyloric cæca of starfishes contain it in great abundance, also the intestinal appendages of *Echinus*, which fact shows that the former function like the so-called liver of other Invertebrates.

(4.) The bile of the crayfish and that of pulmonate Mollusca contains hæmochromogen; in the latter it is generally accompanied by enterochlorophyll, and appears to be concerned more in aerial than aquatic respiration.

(5.) The so-called liver of Invertebrates is a pigment-producing and storing organ, as well as being concerned in the preparation of a digestive ferment.

(6.) The presence of hæmochromogen in the bile of Invertebrates is apparently determined by their mode of living; and it does not appear to be distributed according to purely morphological considerations.

The remainder of the paper deals with vertebrate bile pigments, and contains some observations on abnormal urinary colouring-matters mainly with regard to their spectroscopy. The various bile pigments of Städeler are first dealt with, and some remarks on the bile spectra of animals follow; here it is shown that urobilin can be extracted from the liver of *Salamandra maculata* by means of alcohol, that it is absent from reptilian bile during hibernation, and that the liver of fishes may contain tetronerythrin which can be extracted from it by suitable solvents. The latter fact suggests an analogous function to that of the liver of Invertebrata.

The results of the examination of a green hydrocele liquid are

detailed, which showed beyond doubt that biliverdin was present, and since in that case its origin could be traced to blood pigment, the origin of biliverdin from blood pigment is demonstrated.

The identity of stercobilin and hydrobilirubin got by the action of nascent hydrogen on bilirubin is proved, and a difference between them and febrile urobilin shown to exist.

The statement that the absorption bands of sheep bile are the same as those which occur in Gmelin's reaction is shown to be erroneous, and a brief description of the method of isolating the colouring-matter of sheep bile and the wave-lengths of its different solutions given. Chlorophyll is shown to be absent.

Under the head of urinary pigments, it is shown that the feeble bands described by me in a former paper in the spectrum of febrile urobilin are not due to impurities, but are as much part of the spectrum as the band at F. Urohæmatin, and its difference from hæmatoporphyrin and its pathological significance are discussed. A simple method for the detection of indican in urine, some remarks on uroerythrin, on a peculiar red colouring-matter in pale urine, somewhat like urrhodin, follow. The deductions from this part of the paper cannot be very well given in the form of conclusions, and are therefore scattered throughout the paper.

A drawing of the microscopic structure of the liver of *Limax*, showing the enterochlorophyll within the liver cells, and maps of the most important absorption spectra described, accompany the paper. All readings are reduced to wave-lengths.